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Water Footprint and Economic Productivity of Potato Production in South Africa

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ABSTRACT

An alarming four billion individuals worldwide grapple with acute water scarcity. Notably, South Africa, nestled amongst the world's most parched lands, suffers from severe freshwater limitations, ranking 30th in scarcity indices. Introduced in 2003, the "water footprint" framework offers a valuable technique for measuring water utilization in production systems. The WF is composed of three colors: green, blue, and grey. The present study aimed to investigate the water footprint and economic productivity of potato production in South Africa. Data on potato production, price, and weather data from 2006 to 2015 were obtained from the Potatoes South Africa (PSA), Department of Water and Sanitation (DWS), Department of Agriculture, Forestry and Fisheries, and Food and Agriculture Organization (FAO) databases. Analysis of staple water use, evapotranspiration, and irrigation schemes for crop production was carried out using CROPWAT 8.0 software as well as physical, land, and economic water productivities. Across South African provinces, the water footprint of potato production - encompassing green, blue, and grey components - outstrips global averages, exhibiting notable provincial discrepancies. The result shows that there is a need for more efficient water use across the provinces. PWP was highest in Northern Cape (3.08 t/m³) and lowest in Gauteng (1.99 t/m³). EWP was highest in the Northern Cape (1.0) and lowest in Gauteng (0.65 US$/m³) depicting the high cost of water use per m³ in potato production. ELP, however, was highest in the North West and lowest in the Free State. The scenario could be improved upon by efficient irrigation water use and the application of a minimum level of fertilizer in a bid to ameliorate blue and grey water.

Keywords: *Potato, Footprint, Productivity, Price, South Africa*

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INTRODUCTION

Humanity hangs in the balance as our insatiable thirst pushes freshwater resources to the brink (Dong *et al.*, 2013). Over 2 billion individuals across the globe grapple with extreme water scarcity (Oki & Kanae, 2006). This challenge, already acute, is poised to worsen due to burgeoning populations, escalating economic activity, and the looming specter of climate change (Vörösmarty *et al*., 2000). The water footprint concept (Hoekstra, 2003) has emerged as a crucial tool for evaluating human water usage, particularly in agriculture. It illuminates the sustainability of our water consumption patterns, a vital insight given that an astounding 92% of humanity's total water footprint stems from agricultural activities (Hoekstra & Mekonnen, 2012). Agriculture reigns supreme as the world's most thirsty sector, guzzling upwards of 70% of our planet's freshwater (Lamastra *et al.,* 2014). Recently, mounting concerns about ecological and environmental sustainability have dominated discussions among researchers worldwide. One critical aspect fueling this global conversation is the alarming specter of water scarcity. This phenomenon has become a potent source of stress and anxiety for governments, policymakers, water users and managers, private and non-governmental organizations, and anyone connected to environmental and sustainability issues. According to Mekonnen and Hoekstra (2016), a startling four billion people worldwide struggle with the hard reality of acute water scarcity. Hoekstra (2003) unveiled the water footprint concept, a powerful tool for measuring water consumption within production systems. It encompasses both direct and indirect water use, providing a comprehensive picture for consumers and producers (Hoekstra *et al.*, 2009; Mustarichie *et al.,* 2023). A global assessment of water sustainability across various sectors revealed a sobering truth: Agriculture reigns supreme as the world's water guzzler, devouring a staggering 86% of our freshwater resources (IWMI, 2007). This undeniable link between water, food production, and human survival has rightfully captured the attention of researchers and policymakers, who are now actively seeking sustainable and cost-effective ways to manage water in the agricultural sector.

Water footprint assessment acts as a powerful lens to examine water utilization in agriculture. It details the volume of freshwater consumed in producing specific food or agricultural commodities (Hoekstra, 2011), encompassing rainwater (green), surface and groundwater (blue), and wastewater treatment (grey) across the production chain. Scrutinizing water use in food production through sustainability assessments sheds light on producer behavior regarding available blue water resources. It reveals whether they're tapping into these resources sustainably or exceeding their limits. Economic water productivity is a fundamental component of equitable freshwater allocation. According to Hoekstra (2014), this statistic measures the value that manufacturers create for each unit of water utilized in a particular product. It builds upon calculations of physical water productivity (water output to water input ratio).

Pioneering work on economic water productivity in the food sector has taken root in specific locations. To measure the nation's production concerning water and land, for example, scientists in Tunisia evaluated important crops (Chouchane *et al*., 2015). Schyns and Hoekstra (2014) conducted similar research on important crops in Morocco, and Mekonnen and Hoekstra (2014) investigated water conservation in Kenya through trade. Zoumides *et al*. (2014) further added to this body of knowledge by studying economic water productivity in Cyprus crop production. The water footprint (WF) has become a popular tool for researchers in recent years, with numerous studies employing it to analyze water usage in agricultural production (Chapagain & Hoekstra, 2011; Jefferies *et al*., 2012; Bocchiola *et al*., 2013; Shrestha *et al*., 2013; Gheewala *et al*., 2014; Lamastra *et al*., 2014; Wang *et al*., 2014, 2015; Zhang *et al*., 2014; Xu *et al*., 2015; Suttayakul *et al*., 2016; Salih *et al.,* 2021). These metric sheds light on the varying water consumption patterns of different crops and allows for focused assessments of locally produced crops. All these studies focused on different aspects of WF and economic water productivity of different crops in different countries but no similar studies have been done on potato production in South Africa. Although, a study by Pahlow *et al*. (2015), looked into the water footprint of a few crops in an aggregate manner from 1996–2005 in South Africa but lacked information on potato production in recent years (2006-2015).

Among the world's edible bounty, the humble potato reigns supreme as the third most crucial food crop, trailing only rice and wheat in terms of human consumption. Over a billion individuals across the globe rely on its nourishing tubers, and its global yield surpasses a staggering 300 million metric tons (IPC, 2016). South Africa's 16 diverse potato regions, with key players in Free State, Western Cape, Limpopo, and Mpumalanga, adapt planting times to local climates, keeping fresh potatoes on tables year-round. Over 99,000 tons of potatoes embarked on a journey beyond South Africa's borders in 2015, accounting for a respectable 4.0% of domestic production. This impressive export volume reflected a 6.5% increase from 2014, adding fuel to an already smoldering trend. From 2011 to 2015, South African potato exports skyrocketed by an average of 19.0% annually, with a staggering 98.2% finding fertile ground in SADC, East and Southern Africa, and Western Africa. These regional markets cemented their status as the primary consumers of South African potato bounty (DAFF, 2017).

Analyzing the water footprints of individual crops can be a powerful tool for promoting both economic and sustainable water use in agriculture. This holds particular significance for regions like South Africa, where water scarcity presents a continuous challenge. By understanding the water demands of different crops grown within a region, policymakers and farmers can tailor strategies for efficient and responsible water resource management. The main aims of this study were to assess the WF and economic water productivity of potato production in South Africa from 2006 to 2015.

Decomposing the water footprint, a concept introduced by Hoekstra (2011), reveals three key contributors: green, blue, and grey. The green water footprint, the rain-kissed component, tells the story of rainwater utilization within a production process. It encompasses the total amount of rainwater lost to the atmosphere (evapotranspiration) plus the quantity absorbed and retained by the final product. The blue-water footprint casts its gaze toward surface and groundwater resources, meticulously tracking their consumption within a process. It represents the combined volume of blue water: evapotraspired into the atmosphere, absorbed within the final product, and lost through return flow (water leaving the catchment area or exceeding a specific timeframe). While water withdrawals might paint a larger picture, the true story lies in the 'net' consumption reflected by the blue-water footprint. This measurement considers the return of some withdrawn water to its source, providing a more accurate gauge of blue water usage within a given process. The grey-water footprint acts as a quantifiable measure of the invisible scars left by pollution. It estimates the volume of freshwater needed to dilute contaminants, adhering to existing environmental standards (Hoekstra, 2011).

The water footprint (WF) acts as a powerful lens, revealing the extent to which humans tap into freshwater resources. It captures both direct and indirect water use (Hoekstra, 2011). This multi-faceted metric goes beyond mere volume; it pinpoints how much water is consumed (evaporated or embedded in products) based on its source, and tracks the extent of water pollution by type. Every component of a total WF is anchored in both space and time, providing a detailed picture of water usage (Pahlow *et al.*, 2015; *Al-Ammash et al.,* 2021).

The present study aimed to investigate the water footprint and economic productivity of potato production in South Africa.

MATERIALS AND METHODS

The study area

This study unfolded in South Africa, a land painted by arid landscapes. The nation receives an average of 450 mm of rainfall annually, ranking it 30th in terms of freshwater shortage (DWA, 2013). Its primary source of water, surface water, sustains its parched lands. In rural and arid regions, groundwater serves as a lifeline, whereas substantial amounts of water are recovered from industrial and urban centers' return flows, restocking parched streams. Despite utilizing only 1.5% of its land for irrigation, South Africa manages to cultivate an impressive 30% of its total crops (DWA, 2013). This feat is accomplished, as Backeberg (2005) explains, through efficient water management, with irrigated agriculture claiming roughly 40% of available runoff and the broader agricultural sector consuming over 60% of accessible water (DWA, 2013).

South Africa's potato fields yielded a bountiful harvest over the past few decades, with production jumping from 1.2 million tonnes in 1990 to a record 2.5 million tonnes by 2015. This impressive feat was achieved despite a shrinking potato kingdom, as the cultivated area dwindled from 63,000 hectares to 52,000 hectares. The majority of South Africa's 532 potato-wielding farms (2017) are spread across diverse regions, with most occupying sizeable plots and averaging impressive yields of 34 tonnes per hectare **(Figure 1)**. The nation boasts a highly developed seed potato industry and a bustling potato processing sector, which devours roughly 400,000 tonnes annually (2015), primarily transforming them into frozen french fries and delectable crisps. On average, each South African enjoys a hearty 30 kg of potatoes each year (SA PotatoPro, 2018).

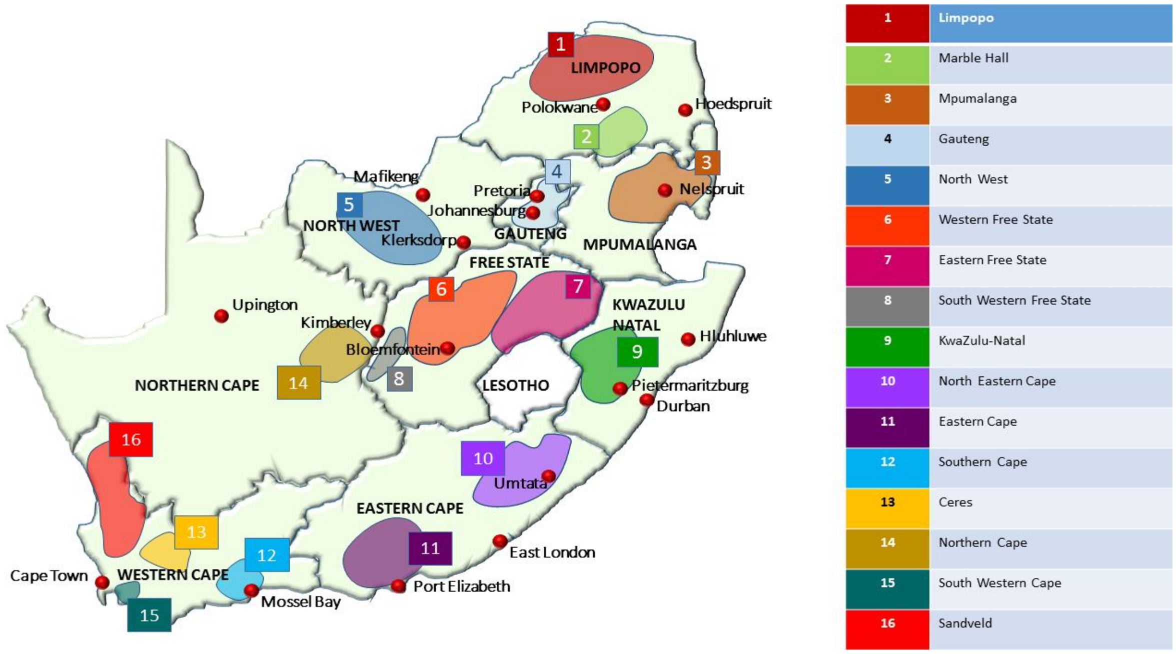

Figure 1. Potato production regions in South Africa
Source: http://www.potatoes.co.za

Data sources and description

This section delves into the second-hand data used in this study, spanning ten years from 2006 to 2015. It provides a comprehensive overview of the data inputs, their sources, and the chosen time frame. Specifically, the data relevant to South Africa's potato production during this period was carefully extracted and analyzed. The volumes of potato production and area planted for the periods of 2006–2015 were obtained from the Potatoes South Africa (PSA), Department of Agriculture, Forestry and Fisheries **(Table 1)**. Weather information was obtained from weather stations across the nation, FAO using CLIMWAT 2.0, and Water-related data was obtained from the Department of Water and Sanitation (DWS). Furthermore, data on producer prices were obtained from PSA and FAOSTAT databases (FAO, 2015).

Table 1. Average potato production, area, and prices in South Africa from 2006–2015

Year	Area harvested (ha)	Production (Mt)	% Share of total area harvested (ha)	% Share of total production (Mt)	Average price ($/ton)
2006	56000	1719	9.16	8.33	316.69
2007	58000	1945	9.49	9.43	304.85
2008	60000	1979	9.82	9.59	330.44
2009	55000	1927	9.0	9.34	342.29
2010	61109	1955	10.0	9.47	379.91
2011	62860	2165	10.29	10.49	326.95
2012	63598	2205	10.41	10.69	393.82
2013	61635	2202	10.09	10.67	331.53
2014	63318	2194	10.36	10.63	243.39
2015	69613	2344	11.39	11.36	293.07

Sources: FAO database, PSA reports, and DAFF, 2017.

Analytical technique and empirical framework

This study's calculations of water footprints leaned heavily on the terminology and practical methods established by Hoekstra (2011). Their widely adopted approach neatly dissects the total water footprint of a particular production chain, revealing the distinct proportions of blue, green, and grey water consumed. In essence, surface and groundwater used in crop production translate to the product's blue water footprint, while rainwater utilized plays the role of its green water footprint. Notably, as Hoekstra (2011) emphasized, the green footprint excludes any rainwater that escapes through runoff. Finally, the greywater footprint captures the quantified volume of water needed to purify contaminated water to acceptable standards.

For South Africa's potato production, blue and green water footprints were determined by using the formula in Eq. (1):

$$WF_{prod,blue,green} = \left(\frac{CWU_{blue}}{Y_t}\right) + \left(\frac{CWU_{green}}{Y_t}\right) \quad (1)$$

Where $WF_{prod,blue,green}$ represents the blue and green water footprint of potato production. The first part of the Eq. (1) represents the blue water footprint. CWU_{blue} represents the crop production and the blue component of crop water usage (Hoekstra, 2011). The green water footprint shown in the second portion of Eq. (1). CWU_{green} indicates the portion of crop water usage that is green (Hoekstra, 2011). According to Hoekstra (2011), the total daily evapotranspiration for crops over their whole growing season represents the crop water usage component of Eq. (1). Eq. (2) provides empirical specifications for this:

$$CWU_{blue,green} = 10\,x \sum_{d=1}^{\lg p} ET_{blue,green} \quad (2)$$

$ET_{blue,green}$ represents the blue and green water evapotranspiration. The factor 10 is used to convert the water depths from millimeters to volumes per area. From the first day of growth till harvest, the entire growing season is included in the summary (Hoekstra, 2011). The leaching-run-off proportion was multiplied by the chemical application rate (AR, kg/ha) for the field to get the crop's grey water footprint (α). The variations in the maximum allowable concentration and the product are split (C_{max}, kg/m3) and the natural concentration of the pollutant is considered (C_{min}, kg/m3). The result is then divided by the crop yield (Y, tonne/ha). This is expressed empirically in Eq. (3):

$$WF_{prod,grey} = \frac{(\alpha \times AR)/(C_{\max} - C_{\min})}{Y_t} \quad (3)$$

While the water footprint (WF) of a crop is typically measured in terms of water per unit of production (m3/tonne or l/kg), it can also be expressed in terms of water per monetary unit (Hoekstra, 2011). Closely linked to the concept of WF is water productivity (WP), a critical metric in light of freshwater scarcity and agriculture's dominant water consumption. Despite the lack of a universal definition (Rodrigues & Pereira, 2009), WP consistently refers to the ratio of benefits gained from agricultural systems to the water used in their production. This can encompass outputs like crops, forestry products, fisheries, livestock, or even combined systems. Physical WP, often known as "crop per drop," focuses on the particular ratio of water required to agricultural yield. Bluewater withdrawal or total (green + blue) water consumption by evapotranspiration are the main ways in which it is expressed (Kijne *et al*., 2003; Playan & Matoes, 2006; Molden, 2007; Kirilmaz, 2022). When considering green and blue water consumption, physical WP (tonne/m3) essentially inverts the green and blue WF (m3/tonne) (Chouchane *et al*., 2015). This concept was adopted in this study and PWP is given as the inverse of Eq. (1).

$$PWP = \frac{1}{WF} \times 1000 \quad (4)$$

While physical water productivity ("crop per drop") tells us how much output we get per unit of water consumed, it doesn't consider the economic value of that output. This is where economic water productivity (EWP) and economic land productivity come in, offering valuable insights for farmers making production decisions. EWP (US$/m3) is calculated by multiplying the physical water productivity (kg/m3) by the crop value (US$/kg). This essentially tells us how much economic value we get per unit of blue water used. For farmers, blue EWP can be particularly relevant as blue water use often incurs direct costs, such as pumping or irrigation fees. Limited blue water availability can constrain production, making EWP a crucial metric for maximizing output within water constraints. Similarly, economic land productivity (US$/ha) is calculated by multiplying the yield (kg/ha) by the crop value (US$/kg). This highlights the economic return per unit of land used. For farmers with limited land availability, prioritizing crops with higher economic land productivity can be crucial for maximizing their profit potential. This expression for the economic water productivity (EWP) is Eq. (5):

$$EWP = PWP \times \Upsilon_{price} \quad (5)$$

Economic water productivity (EWP) takes it a step further, revealing the true monetary value you gain from every cubic meter of water used in your crop production (Chouchane *et al*., 2015). To understand this crucial metric, CROPWAT 8.0 software was used to analyze the water use and evapotranspiration patterns specific to the crop, and the water footprint assessment manual, developed by Hoekstra (2011), was used as a framework for calculating EWP. By combining these tools, we shed light on the economic efficiency of potatoes in terms of water use across provinces in South Africa. This information empowers farmers and policymakers to make informed decisions on water management.

RESULTS AND DISCUSSION

The water footprint of South African potato production versus the global averages from 2006 -2015

Ultimately, comparing South African potato water footprints with global averages provides a crucial lens through which to analyze SA water use patterns and identify opportunities for improvement **(Table 2)**. The findings revealed that the mean green water footprint in the provinces is performing better in green water utilization except in KwaZulu-Natal compared to the global average. Limpopo performed best (46 m^3/ton) followed by Northern Cape (65.5 m^3/ton), and Eastern Cape (93 m^3/ton). Free State has the highest green water utilization and this is because potato production takes place on dry land (without irrigation), especially in the Western Free State (SA PotatoPro, 2018). However, KwaZulu-Natal has a green water footprint (250 m^3/ton) above the global average; this implies poor green water management in the area. Although potato production in South Africa is largely done with irrigation, the agricultural officers in KwaZulu-Natal must look into the best ways of utilizing green water by the farmers in the location. The blue water footprint in all the provinces was above the global average implying a proper management of water use in irrigation as applicable to potato production in South Africa has to be critically looked into. The finding reveals the fact that a lot of water is used under irrigation for potato production with the highest blue water footprint in Western Cape (372.9 m^3/ton) followed by Eastern Cape (363.4 m^3/ton), Gauteng (354.3 m^3/ton) and the least KwaZulu-Natal (243.8 m^3/ton). The grey water footprint which is defined as the level of pollution with regards to water contamination through chemicals (fertilizers) was greater than the global average in all the provinces except

KwaZulu-Natal. This implies that only KwaZulu-Natal farmers were able to efficiently manage the level of pollution by probably using lesser doses of fertilizers for the production of potatoes. Limpopo (286.3 m^3/ton) has the highest level of grey water footprint followed by Eastern Cape (274.4 m^3/ton), Gauteng (228.5 m^3/ton), and North West (211.1 m^3/ton). Generally, the result shows that water use efficiency through irrigation in potato production has to be critically looked into in a region that is water deficient such as South Africa (Phalow *et al.*, 2015).

Table 2. The mean green, blue, and grey water footprint of potato production, 2006-2015

Province	Water footprint (m^3/ton)			
	Green	Blue	Grey	Total
Limpopo	46	332.6	286.3	664.9
Free State	137.3	335.5	198.2	671.0
North West	125.4	325.8	211.1	662.3
Eastern Cape	93.0	363.4	274.4	730.8
Gauteng	147	354.3	228.5	729.8
KwaZulu-Natal	250.4	243.8	51.2	545.4
Mpumalanga	113.9	318.6	210.9	643.4
Northern Cape	65.5	259.3	197.1	521.9
Western Cape	123.9	372.9	249.5	746.3
Global average	191	33	63	287

Source: Authors' calculations, 2019 (using CROPWAT 8.0) and Mekonnen and Hoekstra, 2011.

The water productivity (physical, land, and economic) of potato production in South Africa

The water productivities of South African potato production are shown in **Table 3**. The water productivities were stated in physical, land, and economic terms. For physical water productivity, potato production has a value greater than 3% in Northern Cape followed by Limpopo (2.64%), Mpumalanga (2.31%), North West (2.22%), and the least in Gauteng (1.99%). This result shows a good output from water used in potato production in the provinces. The economic water productivity was highest in Northern Cape (1.0 US$/$m^3$), followed by Limpopo (0.86 US$/$m^3$), Mpumalanga (0.75 US$/m^3), and the least in Gauteng (0.65 US$/$m^3$). These values are high depicting high benefits over the cost incurred in the management of water in South Africa potato production. This result shows that if the management of water especially the blue water is more efficient, then there would be more economic gains than what it is at present. This shows how crucial water is to the value of returns in the potato industry. Economic land productivity is highest in North West province, followed by Gauteng, Northern Cape, Mpumalanga, Limpopo, KwaZulu-Natal, Western Cape, Eastern Cape and Free State. While physical water productivity is a valuable metric, it falls short when assessing water use from an economic perspective (Pereira *et al.*, 2009). Simply focusing on output per unit of water doesn't capture the true cost or benefit of water utilization in terms of economic value. Therefore, shifting the focus to economic water productivity becomes crucial. For profit-driven farms, maximizing the economic output per unit of water, rather than simply physical yield, is paramount. This aligns with their core objective of maximizing profit from their water usage (Molden *et al.*, 2010). This is because blue water's direct link to production costs makes it a key driver for farms. To make sure their profits more than offset the cost of water and other inputs, they place a high priority on optimizing value per unit of blue water.

The contributions made by provinces and regions to South Africa's total potato production are shown in **Figure 2**. Regarding the 2015 crop year, the Limpopo production area planted constitutes the most hectares, i.e. 34.1% of the total hectares planted. The Free State production was second with 32.9% of the total hectares planted (most plantings were on parched land), followed by KwaZulu-Natal (9.6%) and Mpumalanga (6.9%). However, the North West has the largest average yield per hectare which is 60 t/ha, followed by Gauteng and Northern Cape with 57.7 t/ha and 55.3 t/ha, respectively **(Figure 3)**. The region with the lowest yield per hectare is Free State with 32.5 t/ha. This is because cultivation occurs on the dry land. These four major production areas planted 69% of the entire hectares and produced 66% of the national potato crop (SA PotatoPro, 2018).

Table 3. Physical, land, and economic water productivities for potato production in South Africa (2006–2015)

Province	Physical water productivity (t/m^3)	Economic water productivity ($/$m^3$)	Economic land productivity ($/ha)
Limpopo	2.64	0.861859	14781.39
Free State	2.12	0.690144	10604.75
North West	2.22	0.723183	19578
Eastern Cape	2.19	0.714943	12399.4
Gauteng	1.99	0.650908	18827.51
KwaZulu-Natal	2.02	0.660259	13182.52
Mpumalanga	2.31	0.754451	16804.45
Northern Cape	3.08	1.004618	18044.39
Western Cape	2.01	0.656804	12823.59

Source: Authors' calculations, 2019.

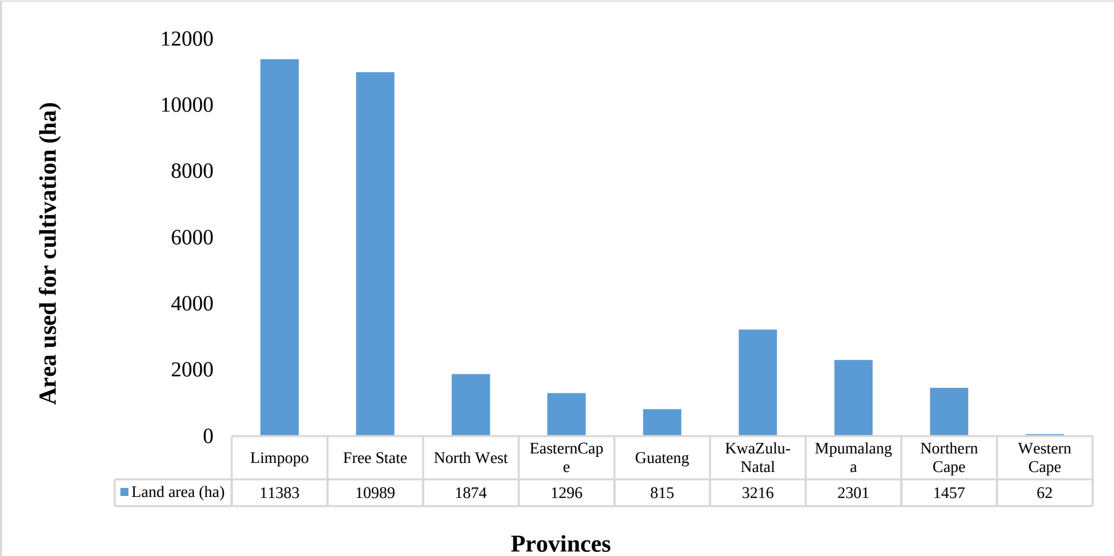

Figure 2. Contribution of regions to aggregate potato production area in South Africa

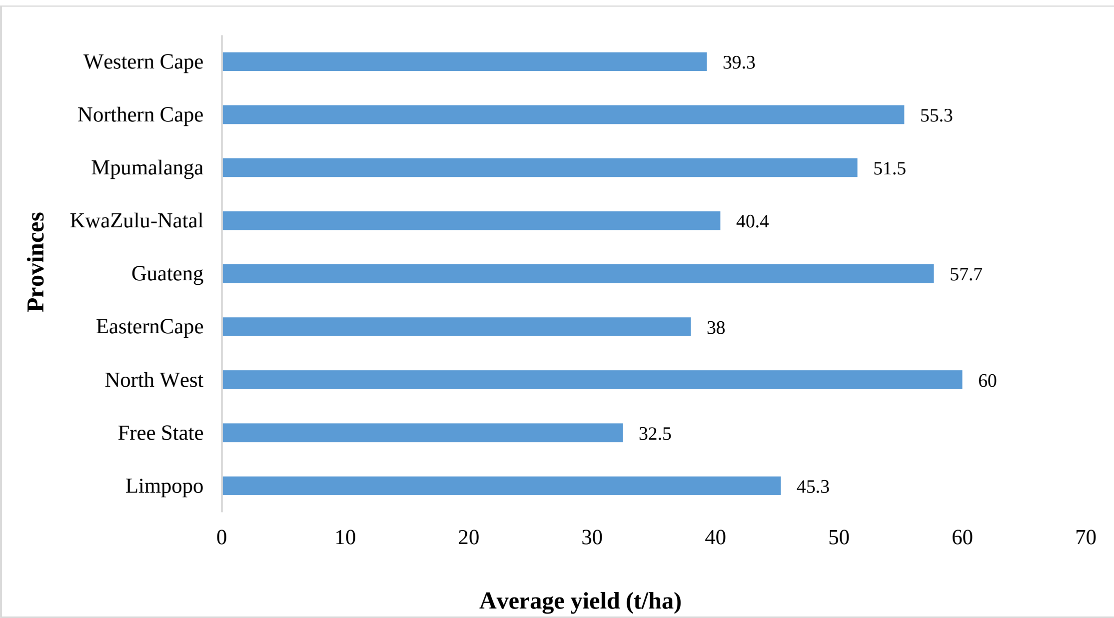

Figure 3. Contribution of different regions to total potato production yield in South Africa

Policy implications of water footprint to South African stakeholders

The relevance of this study to the South African Department of Agriculture can be viewed from the angle of physical and economic water productivity of potatoes and by extension the population at large. A careful look at **Table 4** shows that a lot still needs to be done in the provision of water for irrigation or better put water rationing between population water requirement and irrigation water. The irrigation water deficit for potato production is 62.7% in KwaZulu-Natal province which is the highest followed by Limpopo at 57.2%, Eastern Cape at 44.4%, and Mpumalanga at 38%, respectively. However, the population water requirement is highest in Gauteng (735,850 liters) followed by KwaZulu-Natal (569,250 liters) **(Table 4)**. The findings imply that policymakers in South Africa have to come together to put strategies in place to maximize the use of available water and share the same in more productive ways. In **Table 3**, Northern Cape has the highest physical water productivity (3.08 t/m^3) and economic water productivity (1.0 \$/m^3) followed by Limpopo 2.64 t/m^3 physical water productivity and economic water productivity 0.86 \$/m^3, respectively. This shows that there could be a synergy among all the provinces to deliberate on how to actualize and maximize the potato production potentials using the strategy (ies) of the two provinces.

Table 4. Impact of Water Footprint on the South African Population

Province	Number of households practicing irrigation	Total commercial farm unit	Water for irrigation facility required by farming operations (%)	Water for irrigation deficit (%)	Population ('000m)	Population water requirement (liters)
Western Cape	13,264	6653	34.2	20.3	6621	331050
Eastern Cape	62,904	4006	58.3	44.4	6523	326150
Northern Cape	3,243	5128	29.7	15.8	1226	61300
Free State	39,300	7473	18.8	4.9	2954	147700
KwaZulu-Natal	65,953	3574	76.6	62.7	11385	569250
North West	14,702	4902	24.8	10.9	3979	198950
Gauteng	47,205	1773	33.3	19.4	14717	735850
Mpumalanga	31,998	3523	51.9	38.0	4524	226200
Limpopo	51,433	2934	71.1	57.2	5797	289850

Source: Abstract of agricultural statistics, 2019.

CONCLUSION

The water footprint of potato production in South Africa utilizes more blue water in all the provinces than green water. The province with the highest blue water footprint is Western Cape but has one of the lowest values in economic water productivity among the provinces. The management of water use has to be of paramount agenda in the program of all the provincial authorities in the case of potato production. In the Free State, economic land productivity has to be optimized (through irrigation) rather than water economic productivity while in the rest of the provinces water economic productivity (through efficient irrigation water use) has to be optimized.

Overall, it is agreed that South Africa's total water footprints for potato production are higher than the mean global total water footprints in 1996–2005. However, it can be concluded that South Africa's mean green, blue, and grey water footprints varied from one province to another from 2006–2015. Additionally, it is concluded that from 2006–2015, South African potato producers were making use of more blue water in their production. It is hereby suggested that potato producers should make use of a minimum fertilizer rate because the greywater footprint is high.

Therefore, it is recommended that the Department of Agriculture, Forestry and Fishery in all the provinces ensure farmers optimize water use through irrigation in potato production and minimum usage of fertilizer doses on the farm.

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ETHICS STATEMENT: While conducting the research, it was ensured that the data collection adhered to the 'Rhodes University Research Ethics Policy'.

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